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Effect of perceptual functions level on the development of pre-mathematical concepts in Czech pre-school children

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Abstract

The aspects affecting the academic success of students in mathematics include the level of informal mathematical knowledge and communication skills. Therefore this study analyses the influence of the level of perceptual (visual and auditory) functions on the development of pre-mathematical concepts in 71 Czech pre-school children. The survey was carried out using a standardised foreign test of early mathematical skills and a test of reading and writing risks. The results confirmed the tightness of the relationship between the two variables, which can be described as "medium" addiction.

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Keywords: mathematical concepts; pre-school age; perceptual functions; language skills

1. Introduction

The results of international studies investigating the level of knowledge and skills of pupils in reading, mathematical and scientific literacy show average skills in mathematics in Czech pupils (PISA 2009). When seeking factors that contribute to the child's failure in school mathematics, we found several of them (Ginsburg, 2012): language, socio-economic status and motivation. All three are probably closely related to the adoption of the so-called informal knowledge of mathematics, which a child creates at pre-school age in the interaction with the

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physical and social world, outside the school environment, and which form the basis of school, i.e. formal mathematics.

The pre-school period is characterised by the development of cognitive functions of a child, i.e. an intense development of thinking closely linked with the development of speech (Nádvorníková, 2011). For the development of thinking it is essential for a child to develop the correct terms and have a rich vocabulary, because without a sufficient vocabulary a child cannot clearly express their ideas or think clearly (Henek, 1983, Piaget, 1999, Vygotskij, 2004). It is no different when learning mathematics, which is also associated with the development of language and communication skills (Greenes, Ginsburg and Balfanz, 2004). Blažková (2008, p. 38) in this connection state that *"ninety percent of the problems of intact children in school mathematics is caused by problems in communication between the child and the outside world"*.

Experts (Gelman and Gallistel, 1978, Hejný 1989, Tichý, Hošpesová, Kuřina, 1995, Ginsburg and Baroody, 2003, Ben-Hur, 2004, Kaslová, 2008, Ginsburg, 2012) share the opinion that the foundations of mathematical thinking are considered in the pre-school age of a child. While the development of children's mathematics is dependent on resources that are rich in language and where thinking is supported, in which, the uniqueness is evaluated and discovering new things is supported. Play must be comprehensive so that children use the materials that allow them to count, measure and construct with cubes and clay, make puzzles, listen to stories and also include dramatic plays, music and art.

1. The aim of the research

The aim of the study is to analyse the influence of the level of perceptual (visual and auditory) functions on the development of mathematical skills of Czech pre-school children. Within the research survey, we decided to verify the following hypothesis: *In Czech pre-school children there is a statistically significant difference/relation between the level of perceptual functions and the adopted level of mathematical concepts*.

2. The Research Sample

A total of 71 pre-school children aged 5 years and 9 months to 7 years and 4 months, who regularly attend kindergarten, participated in this research survey.

3. Research Methods

The survey was carried out using a standardised foreign test for early mathematical skills (TEMA 3) and a test for reading and writing risks, which maps the level of visual and auditory perception prior to the child's onset to a primary school. The results in both areas were converted to percentage success and subsequently they were statistically processed.

4. Analysis and interpretation of results

To verify our hypothesis, we first determined the level of mathematical skills and the level of perceptual, i.e. visual and auditory functions that are essential for adopting reading and writing basics. In the area of mathematical skills the monitored group of children achieved on average 86.78 percentage success, in the area of perceptual functions they achieved 72.54 percentage success rate (figure 1).

The subsequent statistical analysis of the results confirmed the tightness of the relationship between the two variables, which due to the value of the correlation coefficient of 0.6252, could be marked as *mean dependence*. (figure 2) Although all children reached a success greater than 50 percent in both areas and the tightness of the relationship between the achieved level of perceptual functions and mathematical skills was confirmed, a number of questions still remain.

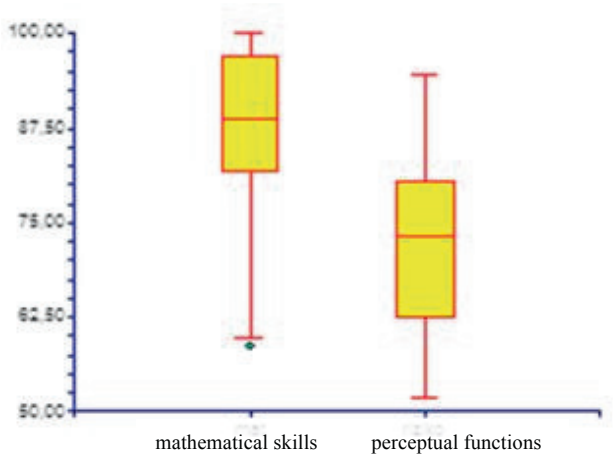

Figure 1: Children's results in the test for mathematical skills and perceptual functions

We believe that one important factor that affects children's mathematical thinking is adult language, not only parents, but also kindergarten teachers and their personal approach to mathematics similarly as it is in the area of art (music and art education). In this context, Moseley (2005) introduces the concept of mediation of mathematical language, by which he refers to a specific dialogue on mathematics between an adult and a child, i.e. connecting language and mathematical skills of the child. The pre-condition for such dialogue to function properly is the chosen level of communication by an adult. While Rudd, Lambert, Satterwhite and Zailer (2008) state that the use of mathematical concepts by kindergarten teachers is inadequate and closely related to inappropriately selected activities. The underestimation of mathematical skills in pre-school children by parents and teachers is also pointed out in our conditions by Tichý, Hošpesová, Kuřina (1995) and Kaslová (2008, p. 116), according to who *"More than half of the kindergarten teachers believe that a child who does not use specific numbers in oral communication, disregards the quantity and does not orient in numbers." She* also notes that *"a child expresses quantity in oral communication with adults differently than when communicating with peers in a spontaneous game and that they have far wider range of verbal means to express certain and uncertain quantities, than the teachers and parents are offered by available professional literature."*

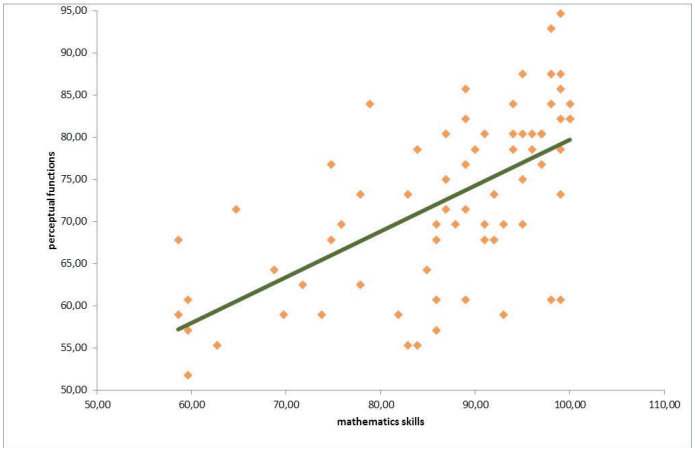

Figure 2: Linear regression between mathematics skills and perceptual functions

5. Conclusion

Based on the literature and our presented results, we conclude that the area of informal mathematics deserves more attention from parents and teachers of pre-school children. In meeting the educational goals of the contemporary pre-school curriculum it is possible to use a variety of educational methods, which effectively contribute to the development in the cognitive functions of a child. These include the Method of Reuven Feuerstein Instrumental Enrichment, which aims to teach children systematic work, creating possible hypotheses, to increase the ability of their attention, teach them to work with assumptions, generate ancillary procedures, and the possibility to control their work and ultimately to expand the conceptual bank; Miniatures school, which through a board defines to the kids the space in which they move, experiencing a thousand adventures with the chess miniatures, counting, develop their geometric perception, spatial orientation, practice their memory and develop logical thinking; or the method of H-mat by Professor Hejný, which is based on building schemes, work in the environments, blending topics, personal development, motivation, the real-life experiences of a child, their own knowledge and experiences while exploring, appropriate challenges for each child, support and co-operation, working with an error and last but not least the role of a teacher as a guide.

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